

SECTION TABLE OF CONTENTS

DIVISION 05 - METALS

SECTION 05120

STRUCTURAL STEEL

06/04

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SUBMITTALS
- 1.3 QUALIFICATIONS FOR STRUCTURAL STEEL WORK
- 1.4 QUALIFICATIONS FOR WELDING WORK
- 1.5 FABRICATION REQUIREMENTS
 - 1.5.1 Tolerances
 - 1.5.2 Connections
 - 1.5.3 Shear Connectors
 - 1.5.4 Column Bases and Bearing Plates
 - 1.5.5 Trusses
- 1.6 BONDING AND GROUNDING
- 1.7 DRAINAGE HOLES
- 1.8 DRAWINGS

PART 2 PRODUCTS

- 2.1 STRUCTURAL STEEL
 - 2.1.1 Carbon Grade Steel
 - 2.1.2 High-Strength Low-Alloy Steel
 - 2.1.3 Corrosion-Resistant High-Strength Low-Alloy Steel
 - 2.1.4 High-Strength Alloy Steel Plate
- 2.2 STRUCTURAL TUBING
- 2.3 STEEL PIPE
- 2.4 CRANE RAILS
- 2.5 STEEL CASTINGS
- 2.6 STEEL FORGINGS
- 2.7 STUD SHEAR CONNECTORS
- 2.8 LOW-CARBON STEEL THREADED FASTENERS
- 2.9 HIGH-STRENGTH THREADED FASTENERS
- 2.10 ANCHOR BOLTS
- 2.11 RIVETS
- 2.12 WELDING MATERIALS
- 2.13 PROTECTIVE COATING
- 2.14 BEDDING MATERIALS
 - 2.14.1 Shrink-Resistant Grout
 - 2.14.2 Cement Grout
 - 2.14.3 Mixing Water
 - 2.14.4 Epoxy-Resin Grout

PART 3 EXECUTION

- 3.1 GENERAL
- 3.2 ERECTING EQUIPMENT
- 3.3 ANCHOR BOLTS
- 3.4 SETTING COLUMN BASES AND BEARING PLATES
- 3.5 FIELD ASSEMBLY
- 3.6 GAS CUTTING
- 3.7 CRANE RUNWAYS
- 3.8 TOUCHUP PAINTING
- 3.9 INSPECTION AND ACCEPTANCE PROVISIONS
 - 3.9.1 Inspection and Tests
 - 3.9.2 Inspection of Welding
 - 3.9.3 Inspection of High-Strength Bolted Connections

-- End of Section Table of Contents --

Crane rail requirements must be coordinated with
Section 14920, "Monorail Systems," or Section 14600,
"Hoists and Cranes," or both as required by the
project.

PART 1 GENERAL

1.1 REFERENCES

NOTE: The following references should not be
manually edited except to add new references.
References not used in the text will automatically
be deleted from this section of the project
specification.

The publications listed below form a part of this section to the extent
referenced:

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 303	(2000) Code of Standard Practice for Buildings and Bridges
AISC 316	(1989; 9th Ed) Manual of Steel Construction, Allowable Stress Design
AISC 317	(1992) Manual of Steel Construction, Volume II, Connections
AISC 326	(2002) Detailing for Steel Construction
AISC M014	(1984; 1st Ed) Engineering for Steel Construction a Source Book on Connections

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B18.22.1	(1975; R 1998) Plain Washers
ANSI B18.22M	(1981; R 2000) Metric Plain Washers

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)

AREMA Manual	(2003) Manual for Railway Engineering (Fixed Properties)
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AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(1998) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS D1.1/D1.1M	(2004) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A 1	(2000) Carbon Steel Tee Rails
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ASTM A 106	(2002) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 108	(2003) Steel, Carbon and Alloy, Cold-Finished
ASTM A 123/A 123M	(2002) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 148/A 148M	(2003) Steel Castings, High Strength, for Structural Purposes
ASTM A 153/A 153M	(2004) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 242/A 242M	(2003a) High-Strength Low-Alloy Structural Steel
ASTM A 27/A 27M	(2003) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A 276	(2004) Standard Specification for Stainless Steel Bars and Shapes
ASTM A 307	(2003) Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
ASTM A 325	(2004) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 325M	(2004) Standard Specification for High Strength Bolts for Structural Steel Joints (Metric)
ASTM A 36/A 36M	(2003a) Standard Specification for Carbon Structural Steel
ASTM A 449	(2004) Standard Specification for Quenched and Tempered Steel Bolts and Studs
ASTM A 490	(2004) Standard Specification for Heat-Treated Steel Structural Bolts, 150 psi Minimum Tensile Strength
ASTM A 490M	(2004) Standard Specification for High-Strength Steel Structural Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric)
ASTM A 500	(2003a) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

ASTM A 501	(2001) Standard Specification for Hot-Formed Welded and Seamless Carbon-Steel Structural Tubing
ASTM A 502	(2003) Steel Structural Rivets
ASTM A 514/A 514M	(2000a) High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding
ASTM A 529/A 529M	(2003) Standard Specification for Structural Steel with 42 ksi (290 MPa) Minimum Yield Point - (1/2 inch (13 mm) Maximum Thickness)
ASTM A 53/A 53M	(2002) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 572/A 572M	(2002a ¹) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality
ASTM A 588/A 588M	(2003) High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point to 4 inch (100 mm) Thick
ASTM A 618	(2001) Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing
ASTM A 668	(2003) Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM B 695	(2000) Coatings of Zinc Mechanically Deposited on Iron and Steel
ASTM C 1107	(2002) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-Shrink)
ASTM C 150	(2002a ¹) Standard Specification for Portland Cement
ASTM C 404	(2003) Standard Specification for Aggregates for Masonry Grout
ASTM C 658	(1998; R 2003) Chemical-Resistant Resin Grouts for Bricks or Tile
ASTM D 2939	(2003) Emulsified Bitumens Used as Protective Coatings
ASTM E 164	(2003) Ultrasonic Contact Examination of Weldments
ASTM E 165	(2002) Standard Test Method for Liquid Penetrant Examination
ASTM E 709	(2001) Standard Guide for Magnetic

Particle Examination

ASTM F 568M

(2002) Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 25

(1997) Paint Specification No. 25, Red Iron Oxide, Zinc Chromate, Raw Linseed Oil and Alkyd Primer (Without Lead and Chromate Pigments)

SSPC SP 10

(2000) Joint Surface Preparation, Standard Near-White Metal Blast Cleaning (NACE No. 2)

1.2 SUBMITTALS

NOTE: Review submittal description (SD) definitions in Section 01330, "Submittal Procedures," and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control. Include a columnar list of appropriate products and tests beneath each submittal description.

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Fabrication Drawings for the following items shall be submitted in accordance with paragraph entitled, "Drawings," of this section.

Structural Steel
Accessories

Installation Drawings shall be submitted in accordance with paragraph entitled, "Drawings," of this section.

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Bolts and Nuts
Washers
Primer
Welding Electrodes and Rods
Shrink-Resistant Grout
Epoxy-Resin Grout
Cement Grout

SD-07 Certificates

Welding Procedures and certificates for Welder Qualifications shall be submitted in accordance with paragraph entitled, "Qualifications for Welding Work," of this section.

Certificates shall be submitted for the following items showing conformance with the referenced standards contained in this section.

Structural Steel
Washers
Bolts and Nuts
Primer
Welding Electrodes and Rods
Shrink-Resistant Grout
Epoxy-Resin Grout
Cement Grout

1.3 QUALIFICATIONS FOR STRUCTURAL STEEL WORK

NOTE: Specifier shall select the appropriate paragraph based on the level of fabricator competency certification required. Level I certification qualifies fabricator for conventional steel structures. Level II certification qualifies fabricator for complex steel building structures. Level III certification qualifies fabricator for major steel bridges. Level MB qualifies fabricator for metal building systems. See AISC Quality Certification Program for additional information.

[Structural steel fabrication and erection shall be performed by an organization experienced in structural steel work of equivalent magnitude.]

[Structural steel fabricator shall be certified by AISC to perform structural steel work at level [I] [II] [III] [MB].]

1.4 QUALIFICATIONS FOR WELDING WORK

NOTE: If Section 05095, "Welding Steel Construction," is not included in the project specification, applicable requirements therefrom should be inserted and the following paragraph deleted.

Welding Procedures shall be in accordance with AWS D1.1/D1.1M.

Certificates for Welder Qualifications shall include the type of welding and positions each operator is qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests.

[Section 05095, "Welding Steel Construction," applies to work specified in this section.]

[Welders shall be certified to have been qualified by tests in accordance with AWS D1.1/D1.1M or under an equivalent approved qualification test.

In addition, tests shall be performed on test pieces in positions and with clearances equivalent to those actually encountered. If a test weld fails to meet requirements, an immediate retest of two test welds shall be made and each test weld shall pass. Failure in the immediate retest will require that the welder be retested after further practice or training and that a complete new set of test welds be made.]

1.5 FABRICATION REQUIREMENTS

AISC 316 and AISC 303 shall govern all work.

Design of members and connections for any portion of the structure not indicated shall be completed by the fabricator and indicated on detail drawings.

Substitution of sections or modification of details, or both, and the reasons for the action shall be submitted with the detail drawings for approval.

Structural steel shall be fabricated and assembled in the shop to the greatest extent possible. Parts not assembled in the shop shall be secured by bolts for shipment.

Shop splices of members between field splices will be permitted only where indicated. Splices not indicated must be approved. Field splices in compound joints will not be permitted.

1.5.1 Tolerances

Tolerances in fabrication and erection shall be in accordance with AISC 303.

1.5.2 Connections

One-sided or other types of eccentric connections will not be permitted, unless indicated in detail and approved.

Shop connections shall be welded.

Field connections shall be bolted, except where welded connections are indicated, as follows:

High-strength threaded fasteners shall be used for bolted connections, except where otherwise specified.

Low carbon steel threaded fasteners may be used only for bolted connections of secondary members to primary members (such as, purlins, girts, and other framing members carrying only nominal stresses) and for temporary bracing to facilitate erection.

High-strength bolting shall conform to AISC 317 and shall be friction-type connections as modified by the bonding and grounding requirements.

Holes shall be cut, drilled, or punched at right angles to the surface of the metal and shall not be made or enlarged by burning. Holes in base or bearing plates shall be drilled. Holes shall be clean-cut without torn or ragged edges. Outside burrs resulting from drilling or reaming operation

shall be removed with a tool making a 1/16-inch 1.6 millimeter bevel.

Bolts shall be inserted into holes without damaging thread. Bolt heads shall be protected from damage during driving. Bolt heads and nuts shall rest squarely against the metal. Where bolts are to be used on beveled surfaces having slopes greater than 1 in 20 with a plane normal to the bolt axis, beveled washers shall be provided to give full bearing to the head or nut.

Low carbon steel threaded fasteners shall be of length that will extend through, but not more than 1/4 inch 7 millimeter beyond, the nuts. Bolt heads and nuts shall be drawn tight against the work with a suitable wrench not less than 15 inches 380 millimeter long. Bolt heads shall be tapped with a hammer while the nut is being tightened. Nuts shall be locked after tightening. Where self-locking nuts are not furnished, bolt threads shall be upset.

1.5.3 Shear Connectors

**NOTE: Delete paragraph heading and the following
two paragraphs when composite construction is not
required.**

Shear connectors shall be shop welded to beams or girders in composite construction. Shear connectors shall be spaced as indicated.

Headed stud-type shear connectors shall be automatically end welded in accordance with the headed stud manufacturer's printed recommendations and by personnel familiar with the installation equipment and procedures.

1.5.4 Column Bases and Bearing Plates

Column bases shall be provided under columns.

Bearing plates shall be provided under beams, girders, and trusses resting on footings, piers, or walls.

Column bases shall be milled and attached to columns as indicated.

1.5.5 Trusses

Top and bottom chords shall not be spliced. If splices are necessary to avoid special handling and shipping problems, chords shall be spliced at panel points at approximately the third points. Center of gravity lines of truss members shall intersect at panel points. When center of gravity lines do not intersect at a panel point, provisions shall be made for stresses due to eccentricity.

Camber of trusses shall be 1/8 inch in 10 feet 3 millimeter in 3000 millimeter.

1.6 BONDING AND GROUNDING

Where indicated, bonding of joints and connections shall be accomplished as specified in Section 16065, "Secondary Grounding." In friction-type joints, faying surfaces shall be clean and abrasive-blasted to near-white metal. Faying surfaces shall be coated to avoid crevice corrosion.

1.7 DRAINAGE HOLES

Adequate drainage holes shall be drilled to eliminate water traps. Hole diameter shall be 1/2-inch 13 millimeter and location shall be shown on the detail drawings. Hole size and location shall not affect structural integrity.

1.8 DRAWINGS

Fabrication Drawings for Structural Steel and Accessoriesshall be in accordance with AISC 316, AISC 326 and AISC M014. Drawings shall show standard welding symbols in accordance with AWS A2.4.

Installation Drawings for structural steel units shall indicate the members and connection areas not to be painted, sequence of erection, and detailed sequence of welding including each welding procedure. Shoring and temporary bracing shall be designed and sealed by a registered professional engineer and provided for record purposes.

PART 2 PRODUCTS

2.1 STRUCTURAL STEEL

2.1.1 Carbon Grade Steel

Carbon grade steel shall conform to [ASTM A 36/A 36M] [ASTM A 529/A 529M].

2.1.2 High-Strength Low-Alloy Steel

High-strength low-alloy steel shall conform to [ASTM A 242/A 242M] [ASTM A 572/A 572M, Grade[____]].

2.1.3 Corrosion-Resistant High-Strength Low-Alloy Steel

Corrosion-resistant steel shall conform to [ASTM A 242/A 242M] [ASTM A 588/A 588M].

2.1.4 High-Strength Alloy Steel Plate

High-strength alloy steel plate shall conform to ASTM A 514/A 514M.

2.2 STRUCTURAL TUBING

Structural tubing shall conform to [ASTM A 500, Grade ____] [ASTM A 501] [ASTM A 618, Grade ____].

2.3 STEEL PIPE

Steel pipe shall conform to [ASTM A 53/A 53M, [Type E] [Type S], Grade B] [ASTM A 106].

2.4 CRANE RAILS

[Rails shall be controlled-cooled, open-hearth carbon steel, ASCE rails conforming to ASTM A 1, No. 1 rails.]

[Rails shall be provided with tight end joints suitable for crane service, joint bars matching the rail section, and joint bar bolts and nuts

conforming to ASTM A 325, ASTM A 325M, complete with AREMA Manual alloy steel spring washers and fixed or floating type rail clamps.]

2.5 STEEL CASTINGS

[Castings shall be medium-strength carbon steel conforming to ASTM A 27/A 27M, Grade 65-35 [____].]

[Castings shall be high-strength steel for structural purposes conforming to ASTM A 148/A 148M, Grade 80-50 [____].]

2.6 STEEL FORGINGS

Forgings shall be mild carbon steel conforming to ASTM A 668, Class E.

2.7 STUD SHEAR CONNECTORS

Connectors shall be made of cold-finished, carbon steel conforming to ASTM A 108, Grade 1015 or 1020.

2.8 LOW-CARBON STEEL THREADED FASTENERS

Bolts and Nuts shall conform to ASTM A 307, Grade A ASTM F 568M, [galvanized according to [ASTM A 153/A 153M] [ASTM B 695] for galvanized members].

Round washers shall be plain, conforming to ANSI B18.22.1, Type B, ANSI B18.22M, [galvanized according to [ASTM A 153/A 153M] [ASTM B 695] for galvanized members].

2.9 HIGH-STRENGTH THREADED FASTENERS

**NOTE: It is generally recommended that ASTM A 490
ASTM A 490M bolts not be used. Do not galvanize
ASTM A 490 ASTM A 490M bolts. These bolts are
brittle and should not be used for cyclic or dynamic
loading.**

[High-strength Washers, Bolts and Nuts shall conform to [ASTM A 325ASTM A 325M] [ASTM A 490ASTM A 490M]. [Galvanize according to [ASTM A 153/A 153M] [ASTM B 695] for galvanized members].]

2.10 ANCHOR BOLTS

[Anchor Washers, Bolts and Nuts shall conform to [ASTM A 307ASTM F 568M] [ASTM A 325ASTM A 325M] [ASTM A 449]. [Galvanize according to [ASTM A 153/A 153M] [ASTM B 695] for galvanized members].]

[Anchor Washers, Bolts and Nuts shall be stainless steel [Type 304] [Type 316] conforming to ASTM A 276.]

2.11 RIVETS

Structural steel rivets shall conform to ASTM A 502, Grade [____].

2.12 WELDING MATERIALS

Welding materials, to include Welding Electrodes and Rods, shall conform to AWS D1.1/D1.1M.

2.13 PROTECTIVE COATING

[Steelwork shall be shop primed with red oxide Primer in accordance with SSPC Paint 25].

[Steelwork shall be shop primed as indicated in accordance with [Section 09970, "Coatings for Steel,"] except surfaces of steel to be encased in concrete, surfaces to be welded, contact surfaces to be high-strength bolt connected, and surfaces of crane rails.]

[Steelwork shall be hot dipped galvanized as indicated in accordance with ASTM A 123/A 123M. Abraded surfaces and cut ends of galvanized members shall be touched up with zinc-dust, zinc-oxide primer, or an approved galvanizing repair compound.]

[Steelwork embedded in concrete shall be coated with a bituminous mastic conforming to ASTM D 2939.]

2.14 BEDDING MATERIALS

2.14.1 Shrink-Resistant Grout

Shrinkage-resistant grout shall be a premixed and packaged ferrous aggregate grouting compound conforming to ASTM C 1107.

2.14.2 Cement Grout

[Portland cement grout shall conform to ASTM C 150, Type I.]

[Aggregate for cement grout shall be clean, sharp, uniformly graded natural abrasive conforming to ASTM C 404, Size No. 2.]

2.14.3 Mixing Water

Water shall be potable.

2.14.4 Epoxy-Resin Grout

Epoxy-Resin grout shall conform to ASTM C 658.

PART 3 EXECUTION

3.1 GENERAL

Erection of structural steel shall be in accordance with the AISC 303, with modifications and additional requirements as specified.

3.2 ERECTING EQUIPMENT

Equipment shall be suitable and safe for workers. Falsework shall be maintained in a safe and stable condition until the steel structure is fully self-supporting.

3.3 ANCHOR BOLTS

Bolts and other connections between structural steel and foundations or existing structural steel shall be performed as part of the work.

Bolts and anchors shall be accurately located and built into connecting work and shall be preset by the use of templates or other methods as may be required to locate bolts and other connections.

3.4 SETTING COLUMN BASES AND BEARING PLATES

Loose and attached column base plates and bearing plates for beams and similar structural members shall be aligned with wedges or shims and shall be bedded with damp-pack bedding. Installation of base and bearing plates shall be as follows:

Concrete and masonry bearing surfaces shall be cleaned free of laitance, dirt, oil, grease, and other foreign material. Concrete surfaces shall be roughened, but not enough to interfere with placing bedding. Bottom surface of base or bearing plates shall be cleaned free of dirt, oil, grease, and other foreign materials.

Space between top of bearing surface and bottom of base or bearing plate shall be approximately 1/24 of the width of the base or bearing plate but not less than 1/2 inch 13 millimeter for base or bearing plates that are less than 12 inches 300 millimeter wide. Base or bearing plate shall be supported and aligned on steel wedges or shims.

[Bedding shall be a mix composed of the specified shrinkage-resistant grout and enough water to provide a flowable mixture without segregation or bleeding.]

[Bedding shall be a mix composed of 1 part portland cement, 2-1/2 parts of the specified aggregate for cement grout, and not more than 4-1/2 gallons 17 liter of water per 94-pound 17 liter bag of portland cement.]

Forms shall be provided to retain bedding until sufficiently hard to support itself.

[Two epoxy-resin grout components shall be mixed with a power-driven explosion-proof stirring device in a metal or polyethylene container having a hemispherical bottom. Polysulfide curing agent component shall be added gradually to the epoxy-resin component with constant stirring until a uniform mixture is obtained. Rate of stirring shall be such that entrained air is minimum.]

[Installation requirements shall be in accordance with the epoxy-resin grout manufacturer's printed installation instructions and as approved.]

3.5 FIELD ASSEMBLY

Structural steel frames shall be assembled to lines and elevations indicated. Various members forming parts of a completed frame or structure after being assembled shall be aligned and adjusted before being fastened. Fastening of splices of compression members shall be done after abutting surfaces have been brought completely into contact. Bearing surfaces and surfaces that will be in permanent contact shall be cleaned before members are assembled.

Splices will be permitted only where indicated. Erection bolts used in welded construction shall be removed and the holes shall be filled with plug welds.

Bracing, adequacy of temporary connections and supports, alignment, and removal of paint on surfaces adjacent to field welds shall be as specified in AISC 303.

Welding for re-drilling will not be permitted. Holes shall not be enlarged more than 1/16-inch 1.6 millimeter larger than the specified hole size without approval of the Contracting Officer.

3.6 GAS CUTTING

Use of a gas-cutting torch in the field for correcting fabrication errors will not be permitted on any major member in the structural framing. Use of a gas cutting torch will be permitted on minor members not under stress only after approval has been obtained from the Contracting Officer.

3.7 CRANE RUNWAYS

[Runways shall be erected complete with columns, girders, beams, bracing, crane rails, crane stops, and other required components as indicated. Gage, alignment, and elevation of rails shall be accurate to a tolerance of plus or minus 1/8 inch 3.2 millimeter. Rail joints shall be staggered with respect to each other on opposite sides of the runway and shall not coincide with girder joints. Top of rails shall be flush at joints.]

3.8 TOUCHUP PAINTING

After erection of structural steel, the Contractor shall touch up bolt heads and nuts, field welds, and abrasions in the shop coat. Touchup and repair shall be accomplished as soon as possible after the damage or installation has occurred.

NOTE: Delete the following paragraph if Section
09970, "Coatings for Steel" is used.

Surfaces shall be degreased, as required, prior to subsequent surface preparation. Degreasing shall be accomplished by steam cleaning or washing with a solution of trisodium phosphate in water, followed by a fresh water rinse. Cuts, welds, and large damaged areas shall be abrasive blasted to near white SSPC SP 10. Blasting abrasive shall be size 16 to 35 mesh per linear 25 millimeter. When abrasive blasting is prohibited or impractical, mechanical cleaning by needle gun or abrasive disks or wheels shall be used. Minor abrasions and scars where extensive rusting has not occurred shall be rendered clean and dry and touched up without further surface preparation. Repair coating shall be applied within 6 hours after surface preparation or before rusting or re-contamination occurs. Touchup and repair material shall be the same inorganic zinc coating as applied in the shop. Application shall be by airless or conventional spray. Compressed air used for blasting and coating application shall be free of moisture and oil. Manufacturer's recommended procedures shall be followed.

3.9 INSPECTION AND ACCEPTANCE PROVISIONS

3.9.1 Inspection and Tests

Inspection by the [Government will] [Contractor shall] include proper preparation, size, gaging location, and acceptability of welds; identification marking; operation and current characteristics of welding sets in use; and calibration of wrenches for high-strength bolts.

3.9.2 Inspection of Welding

Inspection of welding shall be performed in accordance with AWS D1.1/D1.1M, Section 6, "Inspection," and as follows:

NOTE: Delete inapplicable paragraphs. Location of welds requiring inspection and type of inspection must be indicated. Methods of welding inspection are listed in the following paragraphs for increasing cost.

[Liquid penetrant inspection of the welds shall conform to ASTM E 165.]

[Magnetic particle inspection of the welds shall conform to ASTM E 709.]

[Radiographic inspection of the welds shall conform to AWS D1.1/D1.1M, Section 6, Part B.]

[Ultrasonic inspection of the welds shall conform to ASTM E 164.]

3.9.3 Inspection of High-Strength Bolted Connections

Inspection of high-strength bolted connections shall be performed in accordance with AISC 317.

-- End of Section --